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(71)Applicant : HITACHI CABLE LTD

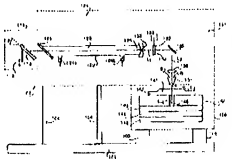
(72)Inventor : IMOTO KATSUYUKI

(54) METHOD FOR CUTTING OFF SUBSTRATE MEMBER AND DEVICE THEREOF

(57)Abstract:

PURPOSE: To provide a method for cutting off a substrate material and a device thereof, which can smoothly and precisely cut off without developing dross and microcrack.

CONSTITUTION: Wave length of light oscillated with carbon dioxide gas laser beam generator 121 is selected to a single wave length with a diffraction grating 112. This laser beam having single wave length is condenced and also, assist gas is flowed along the propagating direction of the laser beam on the outer periphery of this laser beam. Then, while irradiating the substrate material 141 mounted on a light transmissible plate 147 composed of a material which can transmit the laser beam, with the laser beam, the substrate material 141 is shifted to cut off the substrate material 141.



DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to the method of cutting by non-contact by the laser beam to which the substrate material was emitted for example, from the CO_2 laser device etc., and its device.

A smooth cutting plane without dross can be acquired.

[0002]

[Description of the Prior Art]These days, product development of a glass material board, a magnetic material board, a semiconductor material board, and the device that mounted an electronic circuit, an optical circuit, etc. in the dielectric-materials board further has come to be carried out actively. Thousands of [of these devices] are formed in the inside of the above-mentioned substrate, or a table (or reverse side) side from some. Therefore, at the last process, a substrate must be cut and each device must be separated. It is considered as this cutting and separation method, and as shown in drawing 7, the method of performing diamond blade dicing along a dotted line, or irradiating with a laser beam and performing scribing, etc. are used.

[0003]Drawing 8 shows the cutting device (Tokuganhei5-63775) of the glass by the exposure of the CO_2 laser beam which these people proposed previously. This device sprays the assist gas G on the surroundings of laser beam L of the CO_2 laser (carbon dioxide gas laser) 801 from the assist gas introducing pipe 802, and irradiates the glass substrate 804 on the base 803 with this laser beam L, When cutting this glass substrate to the two substrates A and B, vacuum absorption of the glass substrate is carried out to the base 803 by the A and B side, respectively, and it fixes. Laser beam L is the thing it was made to penetrate the glass substrate 804, and the slot 805 provided between the A side B the base 803 sides can maintain the cutting condition same during cutting, when there is the slot 805.

[0004]

[Problem(s) to be Solved by the Invention]When the quartz system and the multicomponent system glass substrate, and the ceramics board were cut using the device of drawing 8, it turned out that the following problems are produced.

[0005](1) As shown in the top view of drawing 7 (a), and the side view of drawing 7 (b), When thickness cut the substrate material 901 of the range of 0.2 to 1.5 mm, unevenness occurred at the surface 903 of the cut cutting portion 902 of the substrate material 901, the side 904, and the rear face 905, and it was not able to cut smoothly. However, there was also a selectively smooth place. Concavo-convex sizes were several micrometers - tens of micrometers.

[0006](2) When it was a multicomponent system glass substrate with thick (>=1mm) thickness, and a ceramics board, survival or ** of cutting, i.e., dross, arose unevenly along the cutting direction at the rear face of the substrate material. The height of the dross was also as uneven as hundreds of [tens to] micrometers. In the case of the ceramics board, the micro crack occurred covering a length of tens of micrometers - hundreds of micrometers on the surface and the side of the cut portion, and the length of the generation place and a micro crack was also uneven. In the case of the multicomponent system glass (for example, borosilicate glass, soda glass, ** glass) board, the big crack might enter locally, and the substrate material might break.

[0007](3) Even if the method of generating the above-mentioned unevenness is irregular and it fixed the strength of the output of a CO_2 laser beam, it turned out that it still generates.

[0008](4) When the above-mentioned dross mounted the cut substrate in a case, it produced the problem that it could not mount with sufficient adhesion. In particular, dross generated the uneven crevice between the case and the substrate, and it has checked that this carries out the hermetic seal of the substrate into a case.

[0009](5) When [which was ultra-thin] the thickness of a substrate was 0.several millimeters, the cut portion was pushed by the wind pressure of assist gas, the lens of the board part which it is going to cut from now on, and the interval between substrate faces were changed, as a result unevenness occurred in the cutting plane and the cutting plane became un-vertical in it.

[0010]The purpose of this invention is to provide the cutting process of the substrate material which can reallze the precise cutting plane which an aforementioned problem is solved, it faces cutting the substrate of various nonmetal materials, and there is no generating of dross, and is smooth and does not have a micro crack, and its device.

[0011]

[Means for Solving the Problem]To achieve the above objects, this invention is performed as follows.

[0012]The 1st invention chooses wavelength of light from a laser device as a single wavelength by a diffraction grating (grating), and controls it, Condensing this laser beam on

a substrate material installed on a light transmission board, and passing assist gas on a periphery of the laser beam toward a propagating direction of this laser beam, and spraying on this substrate material surface. It is the method of cutting a substrate material, making it make a light transmission board penetrate this laser beam, evaporating a substrate material of a portion in which this laser beam was irradiated, and moving this substrate material.
[0013]The 2nd invention is the cutting process of a substrate material using a CO_2 laser device as a laser device in the 1st invention.
[0014]The 3rd invention is the method of carrying out vacuum absorption of the substrate material on a light transmission board, and cutting a substrate material, in the 1st invention.

[0015]The 4th invention is the cutting process of a substrate material using for ZnSe, germanium, GaAs, KCl(s), or such materials what gave an antireflection film as a material of a light transmission board which can make a laser beam penetrate in the 1st invention.
[0016]It is the method of the 5th invention always making a laser device an ON state in the 1st invention, irradiating a substrate material with a laser beam by making open a shutter formed between an emitting end of a laser device, and a lens for condensing when it comes to a portion from which a substrate material is cut, and cutting a substrate material.
[0017]The 6th invention is the cutting process of a substrate material which exhausted compulsorily assist gas currently passed toward a propagating direction of a laser beam from the substrate face side In the 1st invention.
[0018]The 7th invention is the method of cutting a substrate material where it unified a vibration-proof mechanism on a vibration isolation system which it had and a laser device with a diffraction grating and a stage which moves a substrate material in X and the direction of Y are fixed, in the 1st invention.
[0019]A laser device with a resonator with a diffraction grating with which the 8th invention can choose desired wavelength, A lens for making the substrate material surface condense a laser beam which this laser device outputted, A substrate moving mechanism which fixes a substrate material and is moved to at least 1 shaft orientations on a light transmission board which can make this laser beam penetrate, It is a cutting device of a substrate material which consists of a slit part for making this substrate moving mechanism diffuse a laser beam which passed a light transmission board, and spreading, and an assist gas feed zone for maintaining at assist gas atmosphere a laser beam irradiated by substrate face.
[0020]The 9th invention is a cutting device of a substrate material whose laser device is a CO_2 laser device in the 8th invention.

[0021]The 10th invention is a cutting device of a substrate material using a vacuum absorption machine for fixing a substrate material on a light transmission board in the 8th invention.
[0022]The 11th invention is a cutting device of a substrate material which formed a shutter for intercepting or opening a laser beam with an electrical signal between a laser device

and a lens for condensing in the 8th invention.

[0023]The 12th invention is a cutting device of a substrate material which formed the exhaust for providing an enclosure for maintaining a laser beam and a substrate cutting portion at assist gas atmosphere, and exhausting assist gas in the enclosure compulsorily in the 8th invention.

[0024]The 13th invention is a cutting device of a substrate material which unified a laser device with a diffraction grating, a lens system, a substrate moving mechanism, and a shutter on a vibration isolation system with a vibration-proof mechanism, and was fixed in the 8th invention.

[0025]

[Function]By losing the dross of the cutting plane of a substrate, the cut substrate (for example, substrate with which the electric or optical circuit was integrated) can be mounted with adhesion sufficient in metal or the case of a plastic, and the hermetic seal of a case and a substrate also becomes possible. Since other substrates can be made to laminate with sufficient adhesion on the cut substrate now, multilayer high density assembly becomes possible.

[0026]Hold down the end cost width of cutting to the small size width about the spot diameter of a laser beam (for example, CO_2 laser beam), and are smooth, By losing a micro crack, it becomes possible to integrate an electric (or light) integrated circuit with high density in on a substrate, and this becomes possible to attain low cost-ization of an integrated circuit. It becomes possible [preventing the characteristic degradation of the electric (or light) integrated circuit integrated in on a substrate, and providing an integrated circuit reliable also in the long run] to stop the micro crack which results and happens to heat deformation distortion.

[0027]The method of obtaining high quality and high performance electrically and optically and its device are provided by cutting in what is called a clean and dry atmosphere that exhausted the impalpable powder of the substrate material which evaporated compulsorily with assist gas. And it becomes possible to be made to realize such cut processing with sufficient reproducibility.

[0028]Since it is made to cut the substrate material which should be cut to a light transmission board vacuum suction or where adhesion immobilization is carried out mechanically, a substrate material is not blown away by a wind pressure, a forced exhaust mechanism, etc. of assist gas during cutting or immediately after cutting. Since it combines and the substrate of the portion which it finished cutting is always stuck by the light transmission board before cutting and during cutting, even when ultra-thin in the thickness of a substrate, the interval between a lens and a substrate face is not changed with the wind pressure of assist gas. Therefore, uniform cutting is attained.

[0029]The wavelength of a laser beam is controlled by the 1st invention to the single wavelength by the diffraction grating.

Therefore, the laser beam of the always same wavelength is irradiated by the substrate

material.
For this reason, the optical absorption of a substrate material becomes fixed and the quantity of the substrate material evaporated with that absorbed energy is fixed. If a substrate material is moved, since the quantity of the substrate material which does not call at a place but is naturalized will become fixed, there is no concavo-convex generating and it is cut. And making a substrate material evaporate, finally it penetrates a substrate material and the laser beam passes the light transmission board. And since assist gas is sprayed on a substrate face during cutting and it collides with a transmission member, the particles of the vaporized substrate material are blown away and are not attached to the surface of the cut substrate, the side, and a rear face. It stops namely, generating dross. Since a cutting plane is quenched with assist gas, generating of the micro crack by heat deformation distortion is suppressed. Since the laser beam of a fixed single wavelength is always chosen and cut, it becomes possible to cut with sufficient reproducibility.
[0030]According to the 2nd invention, the CO_2 laser device fits cutting of the nonmetal material.
[0031]In the 3rd invention, vacuum absorption of the substrate material is carried out during cutting and on the light transmission board.
Therefore, even if the thickness of a substrate material is thin, the interval between a lens and a substrate face is not changed with the wind pressure of assist gas.
As a result, it becomes possible to perform uniform cutting. The cut substrate is not blown away by the above-mentioned wind pressure.
[0032]In the 4th invention, what gave the antireflection film is used for ZnSe, germanium, GaAs, KCl(s), or such materials as a light transmission board.
Therefore, a laser beam with a wavelength of 9 to 11 micrometers can be made to penetrate by low-loss.
Namely, existence of this light transmission board, without blocking absorption of the laser beam to a substrate material to a laser beam, It functions as a passage which makes penetration material penetrate efficiently, the duty which prevents making it reflect with this light transmission board to assist gas, and passing is carried out, and the duty blown away so that the evaporated particles may not adhere to a cutting plane is carried out. The duty (based on vacuum absorption) which keeps the interval between a lens and a substrate material constant is also carried out.
[0033]In the 5th invention, a laser device is a method which is maintained at the state where it is always oscillating with the single wavelength, and makes a shutter open at the time of cutting.
Therefore, cutting of a uniform substrate material with sufficient reproducibility is attained.

[0034]According to the 6th invention, the particles of the substrate material evaporated by the laser beam are blown away with assist gas, and it becomes possible by carrying out forced exhaust of the gas from the substrate face side to prevent adhesion of the particles

to a substrate face. Since it collides with a light transmission sheet surface and assist gas also cools this light transmission sheet surface, cooling a substrate cutting plane, adhesion of the particles to this surface can also be prevented.

[0035]In the 7th invention, on the vibration isolation system with a vibration-proof mechanism, a laser device with a diffraction grating and a substrate moving stage unify, and are being fixed.

Therefore, both relative position gap does not occur to a foreign vibration or a shock, and uneven unevenness does not arise in the cutting plane of a substrate material.

[0036]From the 8th, according to the device of the 13th invention, when enforcing the method of the 7th invention from the above 1st, cutting of a substrate material can be realized with uniformly and sufficient reproducibility with high degree of accuracy.

[0037]this invention person comes to create and invent the above operation effects out of the result of having repeated various experiments using the device of drawing 8 proposed previously.

[0038]Namely, the surface of the substrate cut like drawing 9 when glass and Ceramics Sub-Division were cut like drawing 7, Unevenness occurs at the side and the rear face, and the method of generating the unevenness is irregular, And although it was not dependent on the strength of the output of cutting speed or CO_2 laser, since it was influenced by component composition etc., the wavelength of the CO_2 laser beam was changed irregularly, and thought that unevenness would occur by the change. Then, when the oscillation-spectrum characteristic of CO_2 laser was measured, wavelength oscillated with 9.1 to 11.3-micrometer large spectrum distribution, and, moreover, it turned out that the output value (strength) of each wavelength within the distribution is not uniform, either (it mentions later to drawing 2). And it turned out that this oscillation-spectrum characteristic is changed delicately and every moment with the temperature change of the cooling water (not shown to drawing 8) of CO_2 laser, the voltage variation of the high voltage power supply supplied to CO_2 laser, the degree of vacuum in a CO_2 laser pipe (not shown to drawing 8), etc. It was presumed that concavo-convex generating was carried out because this oscillation-spectrum width's being wide, i.e., it is a multi-wavelength oscillation, and its oscillation wavelength characteristic are changed. That is, if the substrate material has wavelength dependency in optical absorption, the CO_2 laser beam to which the oscillation wavelength characteristic is changed in oscillation-spectrum width wide as mentioned above is irradiated by the substrate material and a substrate material is cut by this, The cutting plane also became uneven depending on wavelength, and while changing the oscillation-spectrum characteristic, I thought that heterogeneity increased further. When the CO_2 laser beam which is carrying out the multi-wavelength oscillation was condensed by the condenser, the condenser had the aberration by wavelength dependency and I thought

that a cutting plane also became uneven also according to this aberration. This invention drawn from such an idea controls to oscillate with a single wavelength, for example, 10.6 micrometers, so that a CO_2 laser device mentions later (drawing 2). In order to control that dross adheres to the rear-face edge of a cutting plane, fix a substrate on a light transmission board, and it is made to reflect on a transparent plate that it is also with assist gas about the particles which evaporated by the exposure of the CO_2 laser beam, and is made to make it diffuse in the atmosphere. If the mechanism to which a substrate material is moved is oscillating delicately, since it was also found out from the experiment that unevenness occurs similarly, it fixes a CO_2 laser device and a substrate moving mechanism in one on a vibration isolation.

[0039]

[Example]Hereafter, working example of this invention is described in detail based on Drawings.

[0040]The 1st working example of the substrate material cutting device of this invention is shown in drawing 1.

[0041]This device fixes the CO_2 laser irradiation apparatus 102 and the substrate moving mechanism 103 in one on the vibration isolation 101. That is, the CO_2 laser irradiation apparatus 102 is fixed to the vibration isolation 101 via the support 104, and the substrate moving mechanism 103 is being fixed to the vibration isolation 101 via the holding part 105. The CO_2 laser device 121 with which the CO_2 laser irradiation apparatus 102 carried out external [of the external grating (diffraction grating) part 111 which is an external resonator], It consists of the optical system 131 which condenses outputted laser beam L_1 with the lens 136 via the shutter 132 and the mirror 135 and with which it irradiates on the surface of the substrate material 141, and an assist gas introduction system which passes the assist gas G toward the propagating direction of a laser beam on the periphery of laser beam L_3. The substrate moving mechanism 103 consists of the standing ways 142 fixed on X, Y, the Z direction moving mechanisms 143, 144, and 155, and the Z direction moving mechanism 145 of those, the light transmission board 147 placed in a fixed position on the standing ways 142, and the substrate material 141 with which it was equipped on the light transmission board 147. After the slot 146 is established in the standing ways 142 and laser beam L_3 penetrates the substrate material 141, it is devised so that the light transmission board 147 may be penetrated and it may be spread to the slot 146. That is, although laser beam L_3 is spread like L_4, the assist gas G collides and it reflects it in the surface of the substrate material 141, and the surface of the light transmission board 147. The oscillation spectrum of laser beam L_1 oscillated and outputted from the CO_2 laser device 121, . There is no grating part 111 and Brewster window 127 comprised an inner mirror. Since resonance is caused between the above-mentioned inner mirror and the inner mirror 125

attached for another CO_2 laser pipe 122 side in the so-called composition of the former and it is outputted from the output extraction hole 126, As shown in drawing 2 (a), it is oscillating over the wide wavelength range of 9.1 to 11.3 micrometers.
And the power currently oscillated on each wavelength also has distribution.
Having this large oscillation-spectrum distribution and its power distribution had also had an adverse effect, when a certain thing cut a substrate material. The CO_2 laser 121 in the CO_2 laser pipe 122 CO_2, The gaseous mixture 123 which mixed N_2 and helium at a rate of 8:18:74 is enclosed, and in order to carry out discharge required to cause a population inversion in this CO_2 laser pipe 122, the electrodes 124a and 124b are formed. Although the CO_2 laser pipe 122 is not illustrated, it is a double pipe.
The periphery of the CO_2 laser pipe 122 is water-cooled.
On the other hand, the oscillation spectrum of laser beam L_1 oscillated and outputted from the CO_2 laser device 121 of this invention, By changing the angle theta by rotating the micrometer of the adjusting angle part 113 which adjusts the angle theta of the grating 112, Since only the light of a single wavelength (for example, 10.6 micrometers) is selectively taken out out of the above-mentioned wavelength range and it can be outputted, it becomes the oscillation spectrum characteristic like drawing 2 (b). As it said previously that a substrate material is cut by a laser beam with the oscillation spectrum characteristic of such a single wavelength, there is no unevenness in a cutting plane, and a uniform and smooth cutting plane can be realized.
[0042]Next, the cutting process of the substrate material 141 using the device of drawing 1 is described. Before cutting the substrate material 141 first, drive the CO_2 laser device 121, laser beam L_1 is made to output, the shutter 132 is operated with the switch 134 which has insertion/removal mechanism 133, and it is made close. Then, passing the assist gas G, the substrate moving mechanism (this device can be operated by computer) 103 is driven, and the shutter 132 also irradiates the surface of the substrate material 141 with laser beam L_3 as open, and the substrate material 141 is cut. Each drives X of the substrate moving mechanism 103, Y, and the Z direction moving mechanisms 143, 144, and 145 by the pulse motor controlled by numerical control, and they move the substrate material 141 on the light transmission board 147.
[0043]Drawing 3 shows the 2nd working example of the substrate material cutting device of this invention. In this working example, in order to raise the transmissivity of CO_2 laser beam L_3 of the light transmission board 147, an antireflection film is given to the surface and the rear face of the light transmission board 147, and generating of the catoptric light of CO_2 laser beam L_3 is suppressed small. ZnSe, germanium, GaAs, or KCl is used for the

light transmission board 147 here. By giving the above-mentioned antireflection film, CO_2 laser beam L_3 is penetrated without hardly ****(ing) with the light transmission board 147, and is spread like L_4 in the slot 146. When the substrate material 141 is cut also in the case of drawing 1, there is no adhesion of the dross to the back side of the cutting plane of the substrate material 141, but when it is drawing 3, a cutting plane more uniform than the case of drawing 1 can be formed. This is because there is catoptric light of a CO_2 laser beam from the surface of the light transmission board 147 in the case of drawing 1 and this catoptric light has influence of some on the cutting plane of the substrate material 141.

[0044]Drawing 4 shows the 3rd working example of the substrate material cutting device of this invention. In this working example, the adsorption holes 160 and 161 for vacuum absorption are formed in the light transmission board 147 and the standing ways 142, and it exhausts with the vacuum pumps 164 and 165 through the evacuation pipes 162 and 163, and is made to carry out vacuum absorption of the substrate material 141 and the light transmission board 147. By this vacuum absorption, during the cut processing of a substrate material, the substrate material 141 can shift from the light transmission board 147, or cannot move, and the substrate material 141 can be cut with high dimensional accuracy.

[0045]Drawing 5 shows the 4th working example of the substrate material cutting device of this invention. This working example covers X, Y, and the Z moving mechanism 103 with the box 167, and exhausts the inside of this box 167 compulsorily with the exhaust 166. Thus, the air from the outside is not taken into the cutting plane of the substrate material 141 by forming the box 167. As a result, the above-mentioned cutting plane can be maintained at assist gas atmosphere, and can be processed, a cutting plane takes in air, and it deteriorates, or the garbage in the air does not adhere to a cutting plane.

[0046]In each above-mentioned working example, although the CO_2 laser device was used as a laser device, other gas laser devices may be used.

[0047]Next, drawing 4 and the example of cutting of the substrate material using the device of drawing 5 are described.

[0048](Example 1 of cutting) In the device of drawing 4, the oscillation wavelength of CO_2 laser beam L_3 was chosen as the single wavelength of 10.6 micrometers as shown in drawing 2 (b), and PAWA was set as 70W. To the assist gas G, using N_2 gas, N_2 gas was passed so that it might become 3 kg / cm^2 about the gas pressure of the exit (3.5 mm in inside diameter) of the gas introducing guide pipe 151. Pyrex glass (a trade name, the U.S. Corning glass company make) with a thickness [1 mm of] and an area of 100 mm x 100 mm was used for the substrate material 141. 5-mm-thick ZnSe with an antireflection film was used for the light transmission board 147. And making it move in the direction of X at 15 mm/sec in speed, the shutter 132 was opened and the above-mentioned glass plate

was cut. As a result, the uniform cutting plane which can hardly observe unevenness at cutting end cost about 60 micrometers in width was able to be acquired. Dross did not adhere to the surface and the rear face which were cut.

[0049](Example 2 of cutting) In the example 1 of cutting, instead of Pyrex glass, it was made to move in the direction of X at 10 mm/sec in speed, and the with 1.1 mm in thickness and an area of 100 mm x 100 mm alkali-free-glass board (Asahi glass company products) was cut. This result of the cutting plane was also very uniform, and the cutting plane without dross was able to be acquired.

[0050](Example 3 of cutting) In the example 1 of cutting, instead of Pyrex glass, it was made to move in the direction of X at 0.6 mm/sec in speed, and the quartz glass substrate with 1 mm [in thickness] and an area [phi] of 100 mm was cut. This result could also process the cutting plane into the state with very sufficient homogeneity, smoothness, and vertical nature, and did not have dross further, either.

[0051](Example 4 of cutting) In the example 1 of cutting, instead of drawing 4, the device of drawing 5 was used, instead of Pyrex glass, it was made to move in the direction of X at 8 mm/sec in speed, and the with 1 mm in thickness and an area of 50 mm x 80 mm ceramics board (mullite board) was cut. As a result, there is no dross in a cutting plane, and a micro crack was not generated, either. Furthermore at 60 micrometers or less, cutting end cost width was also able to acquire the cutting plane without deterioration.

[0052](Example 5 of cutting) In the example 4 of cutting, instead of a ceramics board, 0.2 mm in thickness. After making it move in the direction of X in sec in 90 mm /first and cutting a half-baking green sheet with an area of 100 mm x 200 mm in the direction of X, subsequently it was made to move in the direction of Y in sec in 30 mm /, and cut also in the direction of Y, and eight green sheets (50 mm x 50 mm) were created. Linearity of the cutting plane was good and it was uniform. All eight sheets were able to be obtained with the sufficient yield, without a green sheet blowing away with the assist gas G during cutting. Assist gas pressure in this case was made into 1 kg / cm^2.

[0053](Example 6 of cutting) In the example 4 of cutting, instead of the mullite board, the barium titanate board (2 mm in thickness) was used, and it was able to be made to have been able to move in the direction of X at 5 mm/sec in speed, and was able to cut, and cutting without deterioration of a cutting plane, a micro crack, and dross was able to be performed.

[0054]Next, working example which carried out the hermetic seal of both other electronic circuit part articles for the glass substrate which cut [above-mentioned] into metal casing is described.

[0055]Drawing 6 is an explanatory view showing the state where inserted the electronic circuit part article 200 between the cut glass substrate 141-1 and 141-2, and the whole was stored in the metal casing 201. Since there was neither a barricade nor dross in the glass substrate 141-1 and the cutting edge part of 141-2 which were cut, it was able to mount with the electronic circuit part article 200, the metal casing 201, and sufficient adhesion.

[0056]Although a glass substrate, a ceramics board, etc. which cut [above-mentioned] passed through the heating process continuously and intermittently at the temperature of tens to 400 ** after that, a cutting plane did not change and they did not deteriorate.
[0057]
[Effect of the Invention]The cutting process of the substrate material of this invention and its device have the following effects.
[0058](1) There was no generating of dross, it was smooth, and the substrate of various nonmetal materials was able to be cut so that there might be no micro crack.
[0059](2) By losing the dross of the cutting plane of a substrate, the cut substrate was able to be mounted with adhesion sufficient in metal or a plastic case. The hermetic seal of a case and a substrate was also easy.
[0060](3) The end cost width of cutting was suppressed to 100 micrometers or less, and cutting speed is also several millimeters/sec to tens of mm/sec in high speed, and was able to raise productive efficiency.
[0061](4) Since the micro crack which results and happens to heat deformation distortion does not occur in a cutting plane, the characteristic degradation of the electric (or light) integrated circuit integrated in on a substrate can be prevented. It turned out that the cut substrate is not deteriorated even if it lets the process of various temperature (tens of ** - 400 **) pass, and long stability Men is also satisfactory.
[0062](5) Since it can cut in a clean and dry atmosphere, quality and highly efficient parts can be obtained electrically and optically.
[0063](6) The ultra-thin substrate material was also able to be cut with high dimensional accuracy.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The lineblock diagram showing the 1st working example of the substrate material cutting device of this invention.
[Drawing 2](a) is the oscillation SUBEKU tram characteristic of the conventional CO_2 laser device. (b) is an example of the oscillation spectrum characteristic of the CO_2 laser device of this invention.
[Drawing 3]The lineblock diagram showing the 2nd working example of the substrate material cutting device of this invention.
[Drawing 4]The lineblock diagram showing the 3rd working example of the substrate material cutting device of this invention.
[Drawing 5]The lineblock diagram showing the 4th working example of the substrate material cutting device of this invention.
[Drawing 6]The explanatory view showing the state where the glass substrate cut by the method of this invention was stored in metal casing with the electronic circuit part article.
[Drawing 7]The top view showing the substrate material for explaining cutting and the separation method of an integrated circuit.
[Drawing 8]The lineblock diagram showing the glass cutter Takeshi device by the exposure of the conventional CO_2 laser beam.
[Drawing 9]The lineblock diagram showing the board cutting device by the exposure of the conventional CO_2 laser beam.

[Description of Notations]
101 Vibration isolation
103 Substrate moving mechanism
111 An external grating part
112 Diffraction grating (grating)
113 Adjusting angle part
121 Carbon-dioxide-gas-laser device

134 Switch
136 The lens for condensing
141 Substrate material
147 Light transmission board
151 Gas introducing guide pipe

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1]After controlling wavelength of a laser beam emitted from a laser device by a diffraction grating to a predetermined single wavelength, condense with a lens for condensing, and. In a method of evaporating a substrate material of a portion in which a substrate material which passes assist gas on a periphery of a laser beam of this single wavelength along a propagating direction of a laser beam, and moves a laser beam which condensed to it was irradiated, and this laser beam was irradiated, and cutting a substrate material, Cutting process of a substrate material carrying a substrate material on a light transmission board which consists of construction material which penetrates a laser beam.
[Claim 2]Cutting process of the substrate material according to claim 1 using a CO_2 laser device as said laser device.
[Claim 3]Cutting process of the substrate material according to claim 1, wherein vacuum absorption of said substrate material is carried out on said light transmission board.
[Claim 4]Cutting process of the substrate material according to claim 1 in which said light transmission board is characterized by giving an antireflection film to boards of ZnSe, germanium, GaAs, or KCl, or these boards.
[Claim 5]Cutting process of the substrate material according to claim 1 intercepting or opening a laser beam by opening and closing a shutter which always made said laser device an operating state, and was formed between an emitting end of said laser device, and said lens for condensing.
[Claim 6]Cutting process of the substrate material according to claim 1 exhausting compulsorily said assist gas passed along a propagating direction of a laser beam from said substrate material surface side.
[Claim 7]Cutting process of the substrate material according to claim 1 fixing said light transmission board carrying said substrate material on a substrate material moving mechanism established by unifying on a vibration isolation system with a vibration-proof mechanism.
[Claim 8]A laser device which has a selectively controllable resonator with a diffraction

grating in desired wavelength, A lens for condensing for making the substrate material surface condense a laser beam which this laser device outputted, A light transmission board for substrate material loading which can make a condensed laser beam penetrate, A substrate moving mechanism which moves a substrate material carried on this light transmission board to at least 1 shaft orientations with a light transmission board, A cutting device of a substrate material consisting of a slit part for diffusing a laser beam after penetrating a light transmission material board formed in this substrate moving mechanism, and spreading, and an assist gas feed zone for maintaining at assist gas atmosphere the circumference of a laser beam irradiated by this substrate face.

[Claim 9]A cutting device of a substrate material, wherein said laser device is a CO_2 laser device.

[Claim 10]A cutting device of the substrate material according to claim 8 having a vacuum absorption machine for fixing said substrate material on said light transmission board.

[Claim 11]A cutting device of the substrate material according to claim 8 forming a shutter for intercepting or opening a laser beam with an electrical signal between said laser device and said lens for condensing.

[Claim 12]A cutting device of the substrate material according to claim 8 characterized by comprising the following.

An enclosure for maintaining the circumference and a substrate material cutting portion of said laser beam at assist gas atmosphere.

And the exhaust for exhausting assist gas in the enclosure compulsorily.

[Claim 13]A cutting device of the substrate material according to claim 8 having unified a vibration-proof mechanism on a vibration isolation system which it had, and fixing a laser device provided with a diffraction grating, a lens system containing a condenser, and a substrate moving mechanism.

[Translation done.]

００、金属ケース２０１と密着性良く実装することができた。

【００５６】上記切断したガラス基板やセラミックス基板などは、その後に数十℃から４００℃の温度で連続的、断続的に加熱工程を経たが、切断面が変形したり、変質することもなかった。

【００５７】

【発明の効果】本発明の基板材料の切断方法及びその装置は次のような効果がある。

【００５８】(1) 種々の非金属材料の基板をドロスの発生がなく、滑らかで、マイクロクラックのないように切断することができた。

【００５９】(2) 基板の切断面のドロスをなくすことにより、切断した基板を金属あるいはプラスチックケース内に密着性良く実装することができた。またケースと基板との気密封止も容易であった。

【００６０】(3) 切断の切り代幅を１００μm以下に抑え、かつ切断速度も数mm／secから数十mm／secの高速であり、生産効率を上げることができた。

【００６１】(4) 切断面には熱変形歪に原因して起るマイクロクラックが発生しないので、基板上あるいは中に集積化した電気（あるいは光）集積回路の特性劣化を防ぐことができる。また、切断した基板を種々の温度（数十℃～４００℃）の工程を通しても変質することがなく、長期的安定性の面でも問題のないことがわかった。

【００６２】(5) クリーンでドライな雰囲気で切断を行なうことができるので、電気的、光学的に高品質、高性能な部品を得ることができる。

【００６３】(6) 極薄の基板材料も高寸法精度で切断することができた。

【図面の簡単な説明】

【図１】本発明の基板材料切断装置の第１の実施例を示す構成図。

【図２】（ａ）は従来のCO_2レーザ装置の発振スペクトラム特性、（ｂ）は本発明のCO_2レーザ装置の発振スペクトラム特性の一例。

【図３】本発明の基板材料切断装置の第２の実施例を示す構成図。

【図４】本発明の基板材料切断装置の第３の実施例を示す構成図。

【図５】本発明の基板材料切断装置の第４の実施例を示す構成図。

【図６】本発明の方法によって切断したガラス基板を電子回路部品と共に金属ケース内に収納した状態を示す説明図。

【図７】集積回路の切断・分離方法を説明するための基板材料を示す平面図。

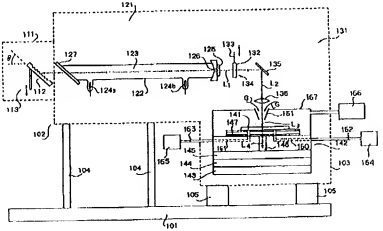
【図８】従来のCO_2レーザ光の照射によるガラス切断装置を示す構成図。

【図９】従来のCO_2レーザ光の照射による基板切断装置を示す構成図。

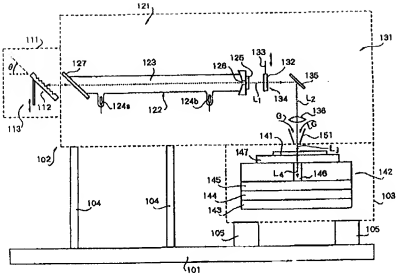
【符号の説明】

１０１　防振装置
１０３　基板移動機構
１１１　外付けグレーティング部
１１２　回折格子（グレーティング）
１１３　角度調節部
１２１　炭酸ガスレーザ装置
１３４　開閉器
１３６　集光用レンズ
１４１　基板材料
１４７　光透過板
１５１　ガス導入ガイド管

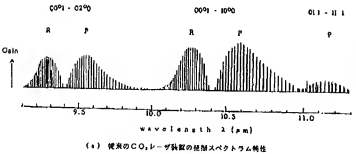
【図５】



【図1】



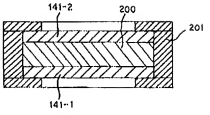
【図2】



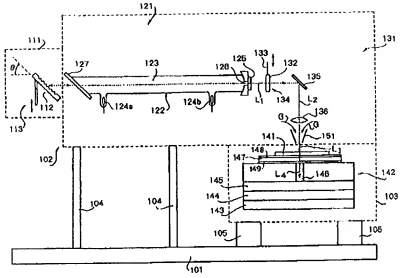
(a) 従来のCO₂レーザ装置の発振スペクトラム特性

(b) グレーティング付CO₂レーザ装置の発振スペクトラム特性の一例
(発振波長10.6μmの場合)

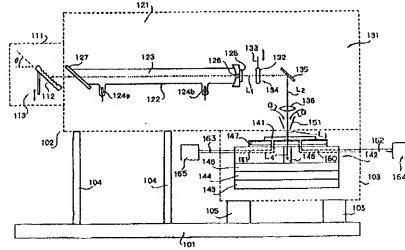
【図6】



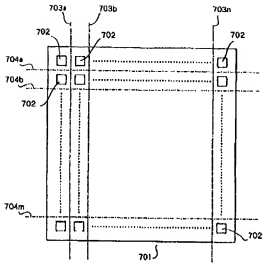
【図3】


121
111
θ1
127
123
120
126
133
132
135
131
112
113
124a
122
124b
L1
134
L2
136
θ2
θ3
141
151
102
147
148
149
L4
146
142
145
144
103
143
104
104
105
105
101

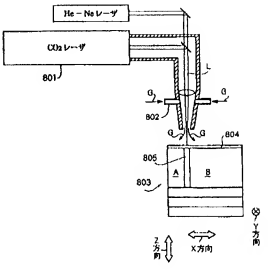
【図4】


121
111
θ1
127
123
126
133
132
135
131
112
113
124a
122
124b
L1
134
L2
136
θ2
θ3
141
151
102
163
147
162
148
149
L4
146
160
142
165
144
103
164
143
104
104
105
105
101

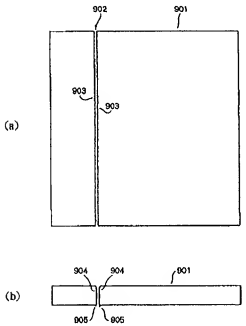
【図7】


703a
703b
703n
702
702
702
704a
704b
702
704m
702
701

【図8】


He－Neレーザ
CO2レーザ
801
L
G
G
802
G
G
804
805
A
B
803
Z方向
X方向
Y方向

【図9】


902
901
903
903
(a)
904
904
901
(b)
905
905